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THE EFFECT OF NEW TECHNOLOGY ON THE OPERATIONAL AND STRATEGIC LEVELS OF WAR: THE DEVELOPMENT OF STEAM PROPULSION IN THE UNITED STATES NAVY PRIOR TO 1860

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

ROBERT P. GRAY, LCDR, USN
B.A., University of Washington, Seattle, Washington, 1982

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

THE EFFECT OF NEW TECHNOLOGY ON THE OPERATIONAL AND STRATEGIC LEVELS OF WAR: THE DEVELOPMENT OF STEAM PROPULSION IN THE UNITED STATES NAVY PRIOR TO 1860 by LCDR Robert P. Gray, USN, 105 pages.

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Thank you.

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CHAPTER ONE

INTRODUCTION

In 1862 the Confederate Navy bloodied the nose of the Union Navy and heralded the end of the proud sailing navy. The success of the former *USS Merrimack* (now called the *CSS Virginia*) in the destruction of the Union sailing sloop *Cumberland* at anchor in the mouth of the James River silenced the critics of the steam-propelled ironclad warship forever.

The story of how the United States Navy developed the steam propulsion that would one day prove its worth in the American Civil War is best described as contorted. Periods of action counterbalanced times of inaction and even retroaction. Tracing the development of steam propulsion in the United States Navy can be a rewarding and informative experience that leaves this researcher with a sense that history is full of lessons relevant to todays problems.

This study will look at what effects the development of steam propulsion in the United States Navy had on the United States strategic and operational levels of war.

If the history of steam development is taken in context, this study can use the modern paradigms "strategic and operational levels of war" for a useful evaluation of steam's effects. The danger lies in trying to study those modern paradigms too closely. This study will focus on the period before 1860 as this period can best detail the relatively uninfluenced U.S. Navy's development in the field of steam propulsion.

The levels of war which will be detailed in the study are the operational and strategic. How these were affected by the introduction of steam propulsion is central to the study. The operational level of war is defined as "the level of war at which campaigns and major operations are planned, conducted, and sustained to accomplish strategic objectives within theaters of operations."[1] In a broad sense, this is further defined as tactical operations that affect a strategic goal.

The strategic level of war can be defined as the level of war "...at which a nation or group of nations determines national security objectives and...uses... resources to accomplish those objectives."[2] This modern definition can be applied to historical examples in the broad sense of national security. How the United States was going to use this new technology to further national aims can be adequately described and researched.

The modern model of the levels of war ties in to national policy (strategy) via military strategy to produce joint operations of which tactical actions are part.[3] How this is applied to the introduction of steam propulsion is detailed in the body of this study. Application of these modern paradigms requires several questions regarding the new technology to be answered. First, how was the new technology developed? This allows a historical retrospective to provide a basis for further questions. Second, what other technologies developed concurrently and how did they support or detract from the development of steam propulsion? Third, how were tactics and operational strategy altered to account for the new technologies? Finally, what was the perception of the civil and military leadership about the new technology? Subordinate to this final question are how logistics were changed. Their effect on geopolitics and the response of foreign governments to United States use of the new steam technology should also be examined.

By applying these questions to the model of this study, it can be determined how steam propulsion affected our Navy and, in a greater sense, our society and the world community of nations.

During our current reduction in defense spending we face serious questions regarding our desire to maintain a technological edge against our probable adversaries. Although one might respond with a resounding "Yes" initially, on reflection certain doubts come to mind.

Do we need to pursue ever increasing advances in technology while on the other hand pursue global peace? Our former superpower foe, the Soviet Union, is no more and the Commonwealth of Independent States is struggling just to survive. These same independent states discuss selling their large war reserves to the highest bidder just to stay financially solvent. Is it then our duty to continually improve weapons systems that, during Desert Storm, proved unstoppable against the fourth largest army in the world? As the United States draws inward and we look to our own shores to solve domestic problems that we have yet to conquer we need to ask these questions.

The prudent student of geopolitics would do well to heed the veiled warning of Bernard Brodie, one of the world's leading nuclear theorists, "Peacefulness of the times tended both to preclude concern over new weapons of war and to lessen interest in their development."[4] It is interesting that what Brodie was discussing was the reluctance of the post-1812 war government to invest in new technology.

This study can be useful in gaining necessary historical perspective before any judgements are made that will change America's course. This study will suggest a parallel between our own time and the period from the end of the War of 1812 to the beginning of the Civil War. New technology, relative peace, and a reluctance to invest capital on updating our military forces are a few of these parallels.

During the War of 1812 America was again at war with the most significant maritime force in the world. Britain had, over the span of two hundred years, produced the strongest and most capable naval force in history. To fight this enemy, whether on land or sea, meant that naval leadership had to consider the tremendous ability to sustain troops ashore and to blockade enemy waters. Consequently, the young Navy of the United States of America needed a force that could withstand the punishment that the best ships-of-the-line could mete out.

During the period 1814 to 1860, the industrial modernization of Western Europe was in full swing. Our own industrialization would not really become a factor until the nation had gone through the tremendous upheaval of civil war. Before this upheaval we see significant evidence that America was slowly moving toward an agro-industrial economy. That is, a society reliant less on agriculture for its well being and more reliant on industry. We were still reliant on our own resources for feeding and clothing our citizenry but relied heavily on the industries of Western Europe for metal. This produced an interesting dichotomy. After 1814, America wanted to free herself from ties in Europe yet was becoming more reliant on that continent's industrial might. She had just gone through her second war in less that forty years and had little desire to attach herself too heavily to the might of Europe, but couldn't free herself of this last vestige of Old Worlds economic transformation.

The military would prove to be the key to the lock that tied America to the Old World. Though much of the research and development of new technologies was privately managed, most of this privately managed research and development was federally funded. The example of steam propulsion in this study is a classic example of military-industrial success. As historian Barbara Tomblin suggests, it was the success of this close working relationship between military and industrial leadership that allowed the Union Navy to build from a small force to a force mounting more than four thousand guns.[5]

For the most part, during the period 1815 to 1860 the powers in the federal government and the politicians in the Senate and House of Representatives believed that the Navy should play a limited peacetime role in commerce protection. This was considered a narrow mission focus and was defensive in nature.[6] Maintaining a fleet large enough to accomplish this narrow strategic focus was not difficult to do and catered to the prevailing sensibilities of most civilian officials. This limited mission required the Navy Department to maintain a fleet of fewer than 24 ships, all sail, and a budget of less than four million dollars.[7]

Save for a few, forward-thinking, Naval officers and civilians, the Navy would have still been fighting Nelsonian battles with sailing ships during the Civil War.

The changes caused by the introduction of steam propulsion to warships cannot be understated. In one sweeping period of history, the Navy changed the effectiveness of warships to the greatest degree in three hundred years.

It can be argued that the technology of steam propulsion had strategic effects far beyond the scope of those promoting its development, including performance of the vessels, strategic resources such as fuel, and the modification of geography in relative distance.[8] This thesis will show that the strategic implications we see now because of the development of steam propulsion can provide a useful model for determining how current technological advances can influence the strategic and operational levels of war.

Although the implications of new technology go far beyond the scope of this study, the development of steam technology provides a framework by which we can judge whether the persuit of new technologies. How steam developed, what its implications to tactics and strategy were, and what resistance to change was present offer key insights into the process of technological adaptation.

It is this study's contention that the strategic and operational levels of war are significantly influenced by the introduction of new technology. The example of steam propulsion affected these levels in the United States Navy like no other technology of the nineteenth century and provides a unique model for analysis.

CHAPTER TWO

LITERATURE REVIEW

The questions of steam technology's effect on the operational and strategic levels of war in the United States Navy prior to 1860 can be addressed by a significant body of work by authors ranging from the 1860s to the present. These works will be addressed in this chapter as most of this material was used extensively for the research phase of this study.

The seminal work as the standard of the history of steam propulsion in the United States is Frank Bennett's Steam Navy of the United States. Printed in 1896, this study documents in great length the production, application, and description of all steam propelled warships in the United States Navy from 1814 until the turn of the century. This work, as powerful as it is, is biased toward the point of view of a U.S. Navy Engineer Corps officer attempting to validate the existence of his corps. As will be shown in later chapters, engineering officers were considered an evil necessity because of the nature of steam propulsion. Because of the animosity that developed early in the United States Navy against steam engineers, a defensive camaraderie developed among those steam engineers. Thus, Bennett tries to justify his corps for the reader. Nonetheless, this treatise stands out as among the most complete and accurate descriptions of the beginnings of the United States' steam Navy.

One hinderance to the development of steam propulsion was the propensity of the contemporary naval officer to denigrate the contributions of steam engineers and sailors. A leading work in the area of sociological implications of the new technology is historian John Alden's The American Steel Navy. Although a photographic essay, it provides in its documentary style the trauma and hardships unique to the American steam engineer, both officer and enlisted. His description of life below decks of the U.S. Navy's earliest steel and steam vessels is certainly one of the greatest yet written.

Another significant work in the area of sociology is Harold Langley's Social Reform in the United States Navy, 1798-1862. Langley focuses on the plight of the common United States Navy sailor and his trials and tribulations during the first 64 years of the Navy. His discussion of the rules of punishment for a sailor in the early days of our Navy is incomparable. One gains real appreciation for the hardships that a common sailor endured for apparently little reason other than his love of the sea.

Naval officers were not immune from the hardships of the sea, and they developed a code of ethics and a brotherhood which had no equal on land. An excellent book to research this unique sea service relationship is Peter Karsten's The Naval Aristocracy. This book, because of the paucity of data available prior to 1840, focuses on the naval officer between 1840 and 1920. It shows that the traditions shared by classmates of Chester Nimitz were also shared by the messmates of Matthew C. Perry and his older sibling Oliver Hazard Perry. In his description of the naval officer Karsten explains that it was the merchant class that provided the majority of Naval officer cadets, midshipmen, thus lending the Navy of the mid-nineteenth century to view its role as that of protector of the nation's commerce.

Harold and Margaret Sprout's The Rise of American Naval Power 1776-1918 is a general overview of the United States Navy. The Sprouts' synopsis of the importance of steam navigation to the development of an American Navy is the standard. Two other strong works in this genre include naval historian and retired Navy Captain Edward Beach's The United States Navy: Two Hundred Years, and the latest work in this field, Royal Geographical Society fellow Stephen Howarth's To Shining Sea. Together, these works provide a solid foundation for anyone starting significant research into the United States Navy.

To gain perspective in how Europeans developed weaponry during this period, we look to Duke University professor emeritus Theodore Ropp's The Development of a Modern Navy: French Naval Policy, 1871-1904. Although this work is after the period of this thesis, it provides the researcher invaluable data on how new technology was treated in Europe. Along with Ropp's work, British historian Edgar Smith's study on the British Navy, A Short History of Naval and Marine Engineering is very useful in gaining a British perspective.

Technology's influence into the everyday American's life is sometimes hard to fathom, even for the most ardent historian. To study technology's influence on a particular society, one that little reflects the society in general, is significantly harder. Prior to becoming an eminent nuclear historian, Bernard Brodie wrote Sea Power in the Machine Age. Although not the only work in its field, this is considered an excellent one volume resource for anyone conducting research into the field of technological advancement and its effect on strategy and tactics.

The socialization of technology is another difficult subject to find studies of and no one does this better than historian Elting Morison in his 1966 book Men, Machines and Modern Times. Originally produced as a series of lectures at a California university, the Massachusetts Institute of Technology professor of management published these lectures in book format. This book provides a unique discussion into man's resistance to accept technological change. In this same genre two other works are significant.

Barbara Tomblin's unpublished doctoral dissertation at Rutgers, "From Sail to Steam: The development of steam technology in the United States Navy, 1838-1862" provides a historical relationship between the commercial shipbuilding programs and the United States Navy. Tomblin's contention is that the military-industrial complex didn't develop in the late nineteenth century, as most historians argue, but started at the earliest stages of the introduction of technology in the Navy, around 1838. She further states that it was because of the close working relationship enjoyed by civilian shipyards and the United States Navy that the Union Navy enjoyed such success in the ensuing Civil War.

Naval tactics and strategy altered little from the sixteenth century until the advent of steam propulsion. Maneuver warfare consisted of a reliance on the forces of nature to ensure victory. Admiral Lord Nelson's victories of the Battle of the Nile and the Battle of Trafalgar were won by men controlling vast fleets of sailing warships. Other new technologies were being implemented during the development of the steam warship and chief among these was the exploding shell gun. Spencer Tucker's work <u>Arming the Fleet</u> is a significant study of this phenomenon. The inclusion of steam and shell technology into naval warfare was as radical a transformation as the galleon of past centuries.

Along with Bernard Brodie's work discussed earlier, the greatest single resource for the changes in tactics under steam propulsion is Admiral S.S. Robison's penultimate treatise A History of Naval Tactics From 1530 to 1930. Written by Admiral Robison after a long and significant career including Commander-in-Chief, United States Fleet, he produces a study of major proportions for the researcher of naval tactics. Although this volume is specifically about tactical employment, it is a worthwhile text from the standpoint that it provides a basis for determining the operational and strategic levels of war.

One cannot discuss tactics or strategy without inclusion of perhaps the greatest single significant historical essay on naval strategy yet published, Rear Admiral Alfred Thayer Mahan's The Influence of Sea Power Upon History, 1660-1783. This work stands alone as the seminal work on the development of naval strategy. Edited from Mahan's many works is the book by John Hattendorf Mahan on Strategy: Selections from the Writings of Rear Admiral Alfred Thayer Mahan. Published in 1991, Hattendorf's selections are timely and timeless, and permit the researcher to peruse a myriad of Mahanian theory, thus allowing further investigation while saving significant research time. Along with the study of tactics and strategy one must study the personalities behind the strategy makers in Washington, D.C.

To study the civilian and military leadership at the time of the development and production of steam warships is significant as it provides the researcher with a solid understanding of the introduction of new technology and the resistance to it by members of both of these important groups. Works in this area are few. Of the ones that have been published the most significant are Paolo Coletta's American Secretaries of the Navy, U.S. Naval Academy professor of history Kenneth Hagan's This People's Navy: The Making of American Sea Power, and former Naval Academy professor Charles Paullins Paullin's History of Naval Administration, 1775-1911.

Coletta's work offers great detail on the lives of the various Secretaries of the Navy and how their tenures were affected by an unwilling Congress and a domineering President, or vice versa. This work allows the researcher to study the continuity of naval administration over the period of transition from sail to steam.

Hagan's book delineates, in part, the history of relationships among the officer corps and the military and civilian populous. Hagan is considered by most historians to be one of the most important modern naval historians today, stating that the personal relationships among these groups played a primary role in the determination of United States policy and use of its Navy.

Paullin's work has long been touted as an important document. His description of the development of naval policy and policy-makers is without peer. Although, at times, he deviates from his title of naval administration--this can be attributed to his having developed this book from a series of lectures at the Naval Academy--it is, nonetheless, the single complete source for this topic.

Research into any field of human endeavor cannot be undertaken without study of certain individuals or events which played a significant role in the study subject. The same can be said of steam technology. Significant events and important persons are the key to understanding the technological development as a whole. Included in this body of work are, once again, A.T. Mahan and his personal journal From Sail to Steam: Recollections of a Naval Life; the preeminent historian Samuel Eliot Morison's work "Old Bruin" Commodore Matthew C. Perry, 1794-1858; readings from New Aspects of Naval History: Selected Papers Presented at the Fourth Naval History Symposium edited by Craig Symonds; historian K. Jack Bauer's Surfboats and Horse Marines: U.S. Naval Operations in the Mexican War, 1846-1848; and Captains of the Old Steam Navy, Makers of the American Naval Tradition 1840-1880, edited by James C. Bradford.

Mahan's work provides a unique window into the life of a junior naval officer at the most important time in the development of the steam propulsion, that of general acceptance into the fleet. He entered the Navy when steam was just coming in to mainstream usage and, much to the chagrin of young Mahan, sail was on its way out. His discussion of how dirty and disgusting life on a steamer was is at once poignant and incisive.

Samuel Eliot Morison's study of Commodore Matthew C. Perry is still the best one source for this man's influence on the Navy. Matthew Perry stands among the few strong advocates of steam propulsion at its genesis, and lobbied most of his professional life for the domination of steam propulsion in the United States Navy.

Washington, D.C. infighting can best be seen in the works selected by Craig Symonds for inclusion in the Naval History Symposium report. Particularly interesting are J. Scott Harmon's article "The United States Navy and the Suppression of the Illegal Slave Trade, 1830-1850," and David F. Long's article "A Case for Intervention: Armstrong, Foote, and the Destruction of the Barrier Forts, Canton, China, 1856."

Researching analyses of the only war during the period of this study was an important factor in formulating the follow-on chapters. The Mexican War was the only full scale conflict during this period and as such, proved to be the testing ground for naval amphibious operations. The steam warship played a small but important role in "logistics over the shore" that has become the trademark of the United States Marine Corps. No work details this better than K. Jack Bauer's. In Bauer's work the important use of steam propulsion in warf is seen for the first time. Although the British and their foes would use steam more extensively in the Crimean War, the Mexican War provided an isolated, American example of the strategic and tactical use of new technology.

Finally, Bradford's study of the old steam Navy's captains provides the "old man's" perspective so critical to many young naval officers. We see significant resistance on their part to changing the modus operandi of the naval service. Frigates sailing on the open ocean with thousands of square feet of canvas was considered the only way to put to sea. The stench and filth of the steam warship invited many uncomplimentary comments from old salts. Lost forever was their romantic image of the naval officer ordering his men to "beat to quarters" for battle or to "hoist the main skysail" to gain tactical footing on an enemy. The captain of a United States Frigate at sea was at one time a father figure and absolute ruler. His orders were not questioned and his voice, when discussing United States policy with foreign diplomates in foreign countries, spoke for the President of the United States. With the advent of steam propulsion, one had only to order a speed by the engine order telegraph and, without voice, the engine room would respond. No romance there.

As discussed earlier, a significant prejudice was delivered into the laps of steam engineers when they were approved by order of Congress in the early 1840's. Chief among these detractors was Admiral David D. Porter, a hero of the Civil War. The prejudice that Admiral Porter had against the engineers was not uncommon and is fully detailed in Naval Engineering and American Sea Power, edited by Rear Admiral Randolph King, and a short study done with Kenneth Hagan as editor titled Naval Technology and Social Modernization in the Nineteenth Century.

Hagan's collection of reports by three prominent historians gives a unique multinational view of the societal influences of new technology.

The answer to the research question in this study cannot be found in any one source. Many sources cover the specific sub-questions detailed in chapter one, but they do not fully answer how the development of steam propulsion affected the operational and strategic levels of war before 1860. Before this question can be fully answered in this study, use of modern paradigms such as "operational and strategic levels of war" must be researched. Bernard Brodie contemplates this in the work discussed above, but he doesn't completely divulge his meanings. This appears to be a problem throughout the research and this thesis had to use Armed Forces Staff College publication number two of 1991 and the Department of Defense Joint Publication number 1-02 to find any detailed information on these two key terms.

To gain perspective on how the civilian shipyard and commercial shipping industries fared during this time of tremendous expansion into a new technology, this study has relied on the work of John G. B. Hutchins, the renowned Harvard economist, titled The American Maritime Industries and Public Policy, 1789-1914, An Economic History. Just as is done today, significant strategic decisions were based on the economics of the era. Presidents Jackson, Monroe, and Martin Van Buren were all held accountable for a staggering post-war economy. This was a consideration for every decision they made, particularly those affecting the expenditure of public funds. Hutchins addresses the paucity of public spending in the shipping industry and the Navy, and how these two were closely tied together.

In this same fashion, John H. Schroeder's work, Shaping a Maritime Empire, The Commercial and Diplomatic Role of the American Navy, 1829-1861, provides perhaps the most valuable asset to the researcher involved in linking American naval policy to the development of new technology. We see numerous examples of this trade-off in Schroeder's work. From the "Commercial Empire in the Pacific," to a role of noninterference postured by the East India Squadron, Schroeder confirms that public policy, economics, and the Navy are inexorably tied together.

Through the commercial development of America's frontier, the annexation of California and Texas, and the vast overseas markets of the Pacific rim, the United States Navy was the one diplomatic arm of the United States that could project our country's will abroad. The Navy's expanding commercial role in the 1840's would play a significant part in the development of steam propulsion as a means of expanding the American commercial empire. Such efforts, Schroeder argues, as the failed attempt by Buchanan's administration to establish naval bases on Santo Domingo and New Grenada (Colombia) are prime examples of the expansionist doctrine that relied on the strongest diplomatic arm of the government--the United States Navy.

Walter R. Herrick, Jr.'s work <u>The American Naval Revolution</u>, although focusing on the post-Civil War Navy, gives us background and insight into how the new technology allowed Pacific and South American expansionism to foster support for the steam Navy. This work is important in that it allows the reader to gain an understanding of what happened diplomatically and socially after the war.

Although the ensuing study focuses on the period 1814-1860, it is imperative for this work to look in the window of time beyond 1860 and before 1814 to gain an understanding of the relative importance of the period in question. With this understanding many works listed in the ensuing bibliography were not listed in this chapter as critical to the research process. Those works were still pivotal to the author's understanding of the time period.

This literature review's intent is to inform the reader of this study of the myriad of publications available. Although this is by no means a complete list of all works available, it does represent the significant literature. One can see that American naval fortune was significantly in the hands of the merchant class of citizen who provided the majority of naval officers after 1845, and strategic use of the Navy was tied to economic fortunes of the country.

The study provides invaluable insight into the post-1812 Legislative and Executive branches of the United States government and the response to public criticism of Navy Secretaries and their officer corps. The literature researched does support the continuing study of new technology's effect on the military-industrial complex and how that relates to strategic and diplomatic goals.

The history of the United States Navy is colorful and resplendent with the characters one might find in a Charles Dickens novel, and they were significant players in the development of steam propulsion and its effects on the operational and strategic levels of war.

CHAPTER THREE

DEVELOPMENT AND NEW ENTHUSIASM

The United States of America was not the first to test and evaluate the utility of steam propulsion on the water. That distinction belongs to a Frenchman. When Dr. Papin (no first name was ever recorded) conducted the first test of steam locomotion in 1707 at Marburg, Hesse (now in western Germany), little did he or anyone else who was there realize that the steam boat would one day revolutionize the way the world was viewed.[1] Although it would take years for his experiment to be commercially feasible, his experiments marked a change in the world order. One-hundred-fifty years would go by after Papin's experiment but man would no longer be satisfied with the winds and the tides for carrying him for commerce or war to distant lands.

The evolution of steam propulsion in the United States, and in particular the United States Navy, can be divided into five distinct periods. The first is the pre-American development. Steam technology was old news to the technicians of Europe by the time the United States Navy would pick it up. Next comes the early American development, marked by significant study and copying of European experiments. Commercialism was the key to steam's success in these early days. Noted historian Eugene Ferguson claims that every time a new technology was produced, in particular steam propulsion, the question that had to be answered was "Will it pay?" Each new design of a steamboat had to be profitable to the merchants who bore the brunt of the development costs.[2] The early development of the steam engine for marine purposes was for a purely commercial purpose.

The early development of steam propulsion technology did not excite anyone of note either in the Federal government or the Navy. No purpose was seen for this system other than commercial. The Navy was still in the grips the "Nelsonian" philosophy of large men-of-war battling on the high seas with fleets of sailing warships. This was not so in Europe.

Next comes the Early development in Europe. Unlike America, European development was for transoceanic commercial transport. Americans saw little use for the technology. Plenty of natural resources allowed them the luxury of building wooden ships with sails long after the supply of those same raw materials was depleted on the continent or in England. The difference, argues eminent British Naval historian Edgar C. Smith, was that England in particular was building steam powered ships that would ply the oceans of the world for commerce, whereas in America steamers were built to transport materials down the vast inland waterways.[3]

The fourth phase of development was America waking up. The United States, after languishing in this "sail or bust" mentality for thirty years, suddenly realized that there was value in developing its own steam technology. One can argue that because of the European success, American business saw an emerging market in the new technology and pushed for its inclusion in the commerce of the nation. Significant manufacturing capabilities were put to the test when merchants demanded the fastest steamers that U.S. shipyards could produce. This same manufacturing base would later support the logrithmic increase in steamship production for the Union Navy later during the American Civil War. The United States was also taking on more significant diplomatic responsibilities, and what better way to show the flag than with a modern Navy? Much resistance was felt, even into the post-Civil War era, that would have to be overcome by forward thinking officers such as Matthew Fountaine Maury and Matthew C. Perry.

The fifth and final stage of development in this study--renaissance--came with general acceptance before the Civil War that steam propulsion was here to stay. The first major battles with steam warships are not in the American Navy, but in the Turkish and Russian Navies.[4] Certainly this period was one of exploration and discovery in terms of steam technology for the American Navy.

Increased diplomatic responsibilities and protection of commerce were the important priorities during this time. Bernard Brodie, the renowned naval scholar-turned-nuclear theorist, states that it was the steam merchant that changed diplomacy. By increasing profits of overseas holdings, this inflated the diplomatic necessity of commercial seaports and trade areas.[5] This inflated diplomatic necessity drove the development of a "modern" Navy of steam warships to further America's cause in far-flung areas of the world.

Pre-American Development

Centuries of slow or no growth in the technology of moving ships through water had occurred before the eighteenth century. As Frank Bennett claims, "sail was believed to be the best work man was capable of."[6]

Papin's experiments, although successful, were far from accepted. Boatmen on the River Hesse were so afraid of Doctor Papin's smoke-belching machine that, on completion of the experiment--as, true to German culture, they were polite enough until then--they destroyed the boat![7]

Several years after Papin's experiments, the renowned British engineer, John Allen, patented underwater jet propulsion by using pumps with a motive force of gunpowder. The significance to steam propulsion was that, in 1729, when his experiment was completed, he recommended further research and that steam might be used as the motive force for the pumps.[8] This system of jet propulsion never materialized because no further mention of it exists in any of the research conducted for this study.

The technology had to be supported either by the state or wealthy individuals. Since, as argued by Elting Morison, society is typically unwilling to make change because of satisfaction with the status quo, it was the purview of the wealthy entrepreneur or the unusually enlightened national leader to fund the developmental process.[9] This is the reason that wealthy estate owner Patrick Miller of Scotland, a weekend scientist and tinkerer, designed a steam powered boat in 1729. The engines for this boat were designed by William Symington, a first-rate British engineer. The boat ran sea trials that summer and reached a speed of seven knots.[10]

Early American Development

Twenty-four years after Miller's experiment with steam propulsion, America received its first steam engine from England. This engine was used in a copper mine in New Jersey until 1768, when it was destroyed by fire.[11] Nothing is written about this early steam engine and its success. Judging from its apparent constant use for 15 years, it seems to have been quite reliable.

The first American government official to comment on the use of steam propulsion was George Washington. In his diary entry for September 6, 1784 he wrote, "...was shown the model of a boat constructed by the ingenious Mr. Rums[e]y for ascending rapid currents by mechanism."[12] K.T. Rowland intimates that General Washington was probably talking of a "pole boat." Rumsey started experimentation with steam boats one year later.

Robert Fulton was an American who, like so many young Americans of his generation, moved to France in 1786 to study art. Fulton stayed, again like so many, for twenty years. During his expatriation he spoke to William Symington, a respected engineer conducting experiments with steam propulsion on the Seine. Fulton, intrigued by what he had seen, saw success in the steamboat design. Rowland described Fulton as a shrewd businessman, gifted artist, and draftsman who saw a commercial use for this steamboat in the United States.[13]

The American ambassador to France, a man named Livingston, believing that his friend Fulton had a grand idea, convinced him to go to England and purchase a steam engine. This would prove to be a sticky problem for Fulton and, as a show of his political acumen, he was able to persuade the King of England to rescind a commerce law forbidding the sale of English technology overseas. In 1804 Fulton left England with his precious cargo. In 1807 Fulton built the *Clermont* and successfully tested his invention on the Hudson river. She steamed without incident from New

York to Albany and back at an average speed of five knots. Fulton was quick to capitalize on *Clermont*'s success and advertised his vessel as a packet for a one-way cost of seven dollars. This was the first commercial passenger service in the United States.[14]

In 1813 Fulton, reacting to public fear of bombardment of the port of New York by the British Navy, petitioned President Madison with plans for a steam battery to be used for the defense of the harbor. Madison, knowing that New York had been the scene of British efforts in the Revolution, supported the petition. In March 1814, Congress approved the construction of one or more steam batteries.[15]

The steam battery *Demologos* (Voice of the People) was built on the East River in four months. Fulton was designated by Madison as the engineer in charge of her construction. She was a large vessel for her time--as the following chart shows, mounting twenty guns and comparing favorably to the 1798 frigates.

Comparison between *Demologos* and *Constitution*

	Demologos	*Constitution*
length	156 ft	175 ft
width	56 ft	43 ft
tonnage	2,475 tons	1,576 tons
cost	$320,000	$303,000[16]

Frank Bennett, preeminent engineer-historian, argues that the *Demologos* changed armament at sea forever. The hull was five feet at its thickest and was strong enough to repel any shot then fielded.[17]

The inventor of the *Demologos* was never able to see his creation to fruition. He died before the ship went out to sea on trials. In his honor, the Navy renamed her the *Fulton*. Even at this early stage of steam development, we see the resistance to change that would become the hallmark of new technology introduction. Captain David Porter, having returned from long sea duty overseas, was assigned as the new captain of the *Fulton*. He saw fit to give his ship sails, as he did not trust steam propulsion alone.[18]

Though the *Fulton* was never to see battle--she was relegated to receiving ship duty in New York until she was destroyed by a gunpowder explosion in 1829--her effect on the British served the purpose that the designer had in mind. Although Robert Fulton never intended that the *Fulton* play a role of deceiver, she frightened England beyond belief. The attitude in England toward the *Fulton* was aprehensive to say the least.

> . . . length on deck, three hundred feet; breadth, two hundred feet; thickness of her sides, thirteen feet of alternate oak plank and cork wood--carries forty-four guns, four of which are hundred pounders . . . and further to annoy an enemy attempting to board, can discharge one hundred gallons of boiling water in a minute . . . .[19]

The Navy was authorized to build one more of this class of vessel but the senior leaders in the Navy were unenthusiastic about the steam battery for coastal defense. They felt that a navy's role was still that of a grand "Nelsonian" battle having an outcome of strategic importance. Congress, on the other hand, felt that steam batteries protected their constituency and this was very important to them.

Congressional legislation in 1816 authorized the President to acquire engines and other materials to construct "steam-propelled floating batteries." Matthew C. Perry, younger brother of the hero of Lake Erie, Oliver Hazard Perry, had no use for this purely defensive construction, according to eminent naval historian Samuel Eliot Morison.[20]

Europe Takes the Lead

Post-1814 America, having just fought the greatest colonial power in Europe for the second time, looked inward and felt little compulsion to build a strong Navy. James Bradford, in his introduction to the work Captains of the Old Steam Navy, claims that the Federal government and career politicians in Washington believed the Navy should play the limited peacetime role of commerce protection. This role significantly narrowed the mission of the 1812 Navy to destruction of enemy shipping and was, on a grand scale, defensive in nature.[21] Governmental and Navy senior leaders' resistance to Navy development opened a major gap in the Navy's ability to accomplish a wartime mission against any likely enemy, that of destruction of enemy shipping and ensuring freedom of navigation of United States commerce. This was not so in Europe, where in the next thirty years designers would develop steam technology at a significantly quicker pace.

The numbers are deceiving, but by 1819 the United States had one hundred registered steam ships (only one steam warship) compared to forty-three steam ships in England. The difference was in their intended use. As British Naval engineering historian E.C. Smith suggests, Britain's ships were designed for the same purpose as America's--for commercial transport--but the environment was different. America's commerce was conducted on the great inland waterways of the Eastern seaboard whereas England's shipping was designed for oceangoing transport. This difference would drive the two countries' navies in two different directions.[22]

The industrial revolution in England was in full swing during the period 1820 to 1850. Brodie shows that in a strategic sense Britain gained an advantage with the production of steam technology in that she was an industrial giant, compared to the United States, and that she was capable of producing superior machinery.[23] As their empire caused Britons to be stationed around the world, the navy was also there.

The British Navy was the diplomatic arm of the realm. England's increasing ability to produce high quality iron, her growing lack of natural resources, and the required policing of the empire drove her to technological advancement.

England also led the rest of the world in coal production. Until 1880 she produced more than all other producers combined. This advantage would most certainly provide some catalyst to steam technology development.[24]

The advancement of continental transportation systems at once helped and hurt the shipping industry. The technological advances brought about by the rail system made it cheaper to transport goods across long strecthes of land mass rather than ship around them. The advantage that was once the purview of ocean transportation was inexorably heading towards rail transportation. Thus, we see the increasing importance of nation-states that are land powers vice those that rely on the sea for their power base.

A refocus on the tactical implications shows that sea powers relative importance vis-a-vis the "Nelsonian" sea battle was lost during this time. A reemphasis on the "industrialized interior" of such nations as Russia, claims theoretician Halford Mackinder, would mean that the superpowers with massive population and industrial strength would rise to dominance.[25]

The implication is that since sea power is not the only indicator of superpower status, the smaller naval tactical victories would lead to strategic and operational victories, and that Alfred Mahan's theory of seapower would require modification.

Commercial shipping was forced, during the twenty years following the end of the War of 1812, to compete with the rail system for inexpensive transportation. This compelled commercial shipping to accelerate advances on steam propulsion. This was true for both the United States and Europe, however both England and France purchased already produced merchant vessels, then armed them accordingly.[26]

The United States Wakes Up

During the 1820's America was looking inward. National expansion was westward through the Cumberland Gap into the vast empire in the west. As a result, the Navy, although assigned to suppress the slave trade in 1820, wallowed in the quicksand of inattention.[27] By 1820 the Navy Department had twenty-four ships and an annual budget of less than four million dollars.[28]

In 1835 the Board of Navy Commissioners, the senior officers in the Navy appointed by the Secretary of the Navy to oversee the day-to-day operations of the Navy, recommended the construction of twenty five steamers. Congress failed to approve this and only authorized the construction of one steam frigate. Although resistance to technological change in the Navy was significant, it was not total. As Lance Buhl suggests in his doctoral dissertation, some form of steam propulsion experimentation was agreed to by both sides of the issue. The question was how much and where it should be applied.[29]

"Victims of fixed attitudes" was how Buhl described Elting Morison's opinion of the fixation on sail warships. "They believe there was only one way for the Navy to function properly: It must sail."[30]

The major detractor to the introduction of steam in the Navy was not Congress, but the Board of Navy Commissioners. Comprised of the most senior naval officers on active duty, the Board was established in 1815 to relieve the Secretary of much of the routine administrative burden of running a navy.

The Board could not keep up with the changing technology and as late as December 1835, Commodore John Rodgers, President of the Board, said that the board didn't know enough about steam propulsion to make educated decisions.[31] It hired Charles Haswell as the first Chief Engineer of the Navy. This critical step in the professionalism of the steam Navy would slowly mark the end of the grip that sail had on the Navy, raising the art of naval warfare to a science--the science of steam engineering. This lack of steam knowledge, along with a love of sail, stultified the Board into inaction at all levels of technological development and eventually led to the Board's dismantling in 1842 under the reform conscious Tyler administration.

Not all naval officers were fixated on the glories of the past, however. One of these forward thinking officers was Matthew C. Perry.

By the 1830's Matthew Perry had an illustrious, though standard, career. At the age of thirty-nine he took command of the New York Navy Yard. One year later, as the commander of the yard, he would be the principal naval adviser during the construction of the second steam warship built from the keel up as a warship. She would eventually be named *Fulton II* in honor of the distinguished designer and promoter of steam.

Significant events occurred during his tenure. Interested for many years in promoting the professional development of the officer corps in the Navy, Perry formed the Naval Lyceum in 1833. It was a forum for naval officers in and around New York to gather and learn about their profession and it was the precursor to the United States Naval Institute, organized in the 1870s. In 1836 they began to publish their ideas in The Naval Magazine. Among the issues discussed in this journal were those of maintaining a strong naval presence around the world, implementing the rank of admiral to ensure parity with the other seafaring nations, ensuring advancement in rank, comparing the U.S. Navy to the navies of Europe, and creating a new class of officers well trained in the profession of arms.[32] As Perry put it, the Naval Lyceum was organized "...to promote the diffusion of useful knowledge, (and) to foster a Spirit of harmony in the Service."[33]

Matthew Perry (.ersaw the three-year construction of the *Fulton II*. When she was completed, *Fulton II* would displace 700 tons and be propelled by steam-powered side wheels. She was 180 feet long, with two engines capable of producing 650 horsepower. It was no surprise to anyone that, when she was commissioned in December 1837, she was commanded by 43-year-old Post-Captain Matthew Perry. Although he was considered too senior for the position of ship's commanding officer, Secretary of the Navy Mahlon Dickerson felt the only way he could garner Congressional support for steam technology was to have a well-known and well-liked officer in that position.[34] Perry was known as a superior politician and enjoyed the attention of many Congressmen.

It is well recognized that Perry is considered the "Father of the Steam Navy." He promoted the idea of a professional engineering corps. He gave his engineers, all of whom were civilians before being hired on to steam the

Fulton II, top pay for their work. Four assistant engineers were hired at $500 to $800 dollars per year. Six firemen were hired to tend the engines and boilers at $25-$30 dollars per man, per month, and four coal heavers at $15 dollars per man, per month for grueling work.[35]

By the mid-1830's dichotomy existed between the commercial steam boat industry and the United States Navy. In 1835 more than 700 commercial steam boats plied the coastal and inland waterways of the United States.[36] However, that same year there was only one active naval warship--the *Sea Gull*--of 100 tons and light armament.[37] She was designed by a commercial firm for commercial purposes and purchased by the Navy. This gap in operational and strategic capabilities, especially compared to that of England and France, caused significant worry to many forward-thinking naval officers.

> The Navy of England now in commission amounts to twenty-three ships of the line, fifteen frigates, fifty-one sloops, twenty-five brigs and schooners . . . and twenty-one armed steamers . . . . The Navy of France . . . is fifteen ships of the line, thirteen frigates, and eighty-eight smaller vessels, including twenty-three steamers . . . . Our Navy . . . if increase voted at the last session of congress, to two ships of the line, seven frigates, fourteen sloops, and seven smaller vessels . . . . What an enormous disparity does this statement show between our developed and available force and those of England and France![38]

Naval Magazine went on to say that the United States should have a Navy equivalent to England and relative to the amount of commerce that traveled by sea. At this time that was roughly 400 to 600 million dollars.[39]

Tactically, the major objection to steam for warships, in naval and civilian circles, was that the machinery had to be placed on the gun deck or higher to provide the motive force for the paddle wheels. It was extremely vulnerable to shot and was considered a ridiculous tradeoff from mounting more guns.[40]

In 1838 Perry commented that "Every intelligent man that I have conversed with seems to be fully impressed with the opinion that the destinies of great maritime nations...controlled by a power for which steam will be the great governing element."[41]

In May of that year Perry steamed *Fulton II* to Washington, D.C. where he helped convince key members of Congress to support steam development. The next May, Congress authorized the building of three steam frigates.[42] Known as the Naval Appropriations Act of 1839, this marked a significant shift in political support for the increased strategic role of the Navy.

The passage of this act was against the will of Secretary of the Navy James K. Paulding. A staunch conservative Virginian, Paulding was against a total steam Navy. He argued against going headlong into development of this steam Navy but realized he was bucking the tide.

> But such fevers [steam propulsion advocates], like all others, must pass through their various stages and the people . . . must have some mania to excite them. . . . we must yield . . . to the majority in this as in other things; for . . . the man who opposes the world is a fool for his pains.[43]

The warships that were built from the Naval Appropriations Act of 1839 were named *Missouri* and *Mississippi*. With a length of 229 feet, width of forty feet and weighing in at 3,200 tons, they were the largest steam warships afloat. Three years in the building, they and the United States warships that followed were hindered by many factors, such as the extra space and weight required for the steam machinery, engine development that lagged behind that of Europe, the cost of coal and spare parts, shrinking budgets, and the tactical implications of the placement of the paddle-wheel discussed later in this chapter.

As Buhl argues, commercial shippers tolerated the extra weight and space of the machinery, but steamers in the Navy meant less space for munitions, armor, and especially stores.[44] This last item was the single most important strategic consideration. With more limited stores on board, a steamer couldn't stay on station as long as its sailing counterpart. More frequent port calls for resupply of coal and other supplies meant less time available for operational employment, a limitation that would be resoundingly reinforced during the Mexican War in a few short years.

The decade between 1830 and 1840 saw the greatest scientific growth in the Navy's history. The Naval Observatory, with Lieutenant Matthew F. Maury as the officer-in-charge, charted previously unknown currents, tides, and depths starting in 1830. The coast survey of the United States, directed by the Federal government and performed by the Navy, occurred between 1834 and 1836.

Last, but perhaps most important in a strategic sense, was the Naval Exploring Expedition of 1838. Under the command of Lieutenant Charles Wilkes, the squadron of two sailors and one steamer took five years to complete its mission. This was the first significant operational use of a steamer. The expedition charted and explored the vast unknown of the Atlantic and Pacific oceans.

Steam Enthusiasm in the United States

With the success of the *Mississippi* and *Missouri*, the United States began steam technology development in earnest. In September 1841, the Tyler administration authorized the construction of the *USS Princeton*. Under the leadership of perhaps the strongest Secretary of the Navy in the nineteenth century, Able P. Upshur, the Navy would now pursue steam propulsion technology with vigor.

By the late 1830's Swedish engineer John Ericsson--who had been in England for several years promoting his newly designed screw propeller and trying desperately to revolutionize steam propulsions effectiveness--was receiving little attention from the British Admiralty.[45] Captain Robert F. Stockton, who would later gain fame in claiming California for the United States, had been to England and seen Ericsson's work. Convinced that the screw propeller would revolutionize steamers, Stockton promised Ericsson that the United States government would build a warship on his design.[46] Stockton, a bold individual, had absolutely no authority to make this claim. The government apparently made no issue of this fact, however, because Ericsson's screw propeller was put to good use on the *Princeton*.

Completed in 1844, *Princeton* was 164 feet in length, 30 feet in width, weighed 954 tons, and was the first steam-screw warship ever built.[47]

The significance of the *Princeton*, other than the screw, was threefold. First, she was the first warship in the world where the machinery was all placed below the water line. This is significant because this meant the machinery was protected from the dangers of shot. Second, she was the first vessel in the world to use anthracite coal (available in abundance in Pennsylvania) which reduced the smoke emanating from the stack--a significant tactical advantage. Finally, she was the first American warship to use the exploding shell-firing gun. Twelve inches in diameter, this gun designed by Stockton was the biggest naval gun employed.[48]

On George Washington's birthday in 1844, Captain Stockton invited many Washington, D.C., dignitaries for a cruise from Washington to Mount Vernon and back. Stockton's "Peacemaker" gun was fired several times to the delight of the crowd. After drinks and light fare below decks, Secretary of the Navy Gilmer, having just replaced Upshur who moved to the Secretary of State position, acquiesced to the desires of the party and allowed the gun to be fired again. The gun exploded, killing Upshur, Gilmer, and several others, including the President's father-in-law. President Tyler was below decks when the tragedy occurred.[49] This tragedy provided the catalyst for an upswell of anti-navalist retrenchment in Congress during the critical years before the Mexican War and caused the relationship between the Navy and John Ericsson to deteriorate to the point where Ericsson was dismissed from service to the Navy.

Like many new technologies, the screw propeller wasn't perfect. Arguments at the time included that the paddle wheel was quieter, provided more stability in heavier seas, and the vibration of the shaft which propagated through the hull put undue stress on the wooden hulls. The problem of support of the shaft after penetration through the hull was not adequately solved until the introduction of lignum vitae (a type of wood) as the internal bearing shaft support mechanism for the strut shaft.[50]

In December 1843, the Navy launched the first American iron warship, *USS Michigan*. Her lines were based on a commercial packet which was in service on Lake Erie. The Navy Department decided to rely on commercial shipyards for the construction of this iron warship as the technology didn't exist in Navy yards.[51] Due in part to the fresh water of the Great Lakes, the *Michigan* stayed in service until 1903.[52]

This experiment and others regarding the design of iron and iron-clad hulls became the hallmark of technological acceptance in the Navy. From this time forward the United States Navy would be in the forefront of technological innovation. Fearing that the great Paixhan guns were being employed by the British and French Navies--with exploding shot--that the construction of ironclad warships with wooden framing became *de rigueur* in the United States.

The Mexican War

The War with Mexico is the only significant military action in the period of this study and merits special consideration as a watershed in the early development and acceptance of steam propulsion in the Navy. The United States Navy's initial mission, according to historian K. Jack Bauer, was to keep the seas clear for the passage of troops and supplies ashore.[53]

As this study will explore, this mission was drastically refined by the end of the two years, partially under the guidance of Commodore Matthew Perry who replaced Commodore David Connor halfway through the conflict. It is the opinion of this study that this unusual move of replacing the commander in the field, though successful, was politically motivated.

It is well known that Matthew Perry was a good self-promoter and a strong advocate of steam propulsion. He was in close contact with the powers in Washington. He had found an ear in the Tyler Administration, in the personage of Secretary Upshur, and through this conduit was able to secure himself the position of Commodore of the Home Squadron. When he arrived in theater he had with him three steam warships including the *Mississippi,* which he commanded.[54]

This infusion of steam technology added significant capability to the blockading force, argued Bauer. Before

Perry's ships arrived there were only five ships blockading the Mexican Coast as the other steamers in theater were felt to be too valuable a tactical asset to use as a blockading force.[55] It is interesting that the first steam vessel used in the Mexican War, on May 8, 1846, was the steamer *Monmouth*--a United States Army vessel.[56]

As later chapters of this study will show, other strategic and operational lessons are learned from the Navy's experience in the Mexican War. However, United States planners fell into the same trap after this war as in all U.S. wars. The United States would look inward to the growing dissention and socio-economic problems facing the issues of slavery and state's rights.

After the Mexican War the old feeling of retrenchment cropped up again as it did in the 1820's and 1830's. Many naval officers and Congressmen felt that steam, fine for some instances, was still an auxiliary mode of propulsion. Besides, the expense of purchasing coal and supplies for these steamers was prohibitive.[57]

Naval development crawled at a snail's pace until the 1850's because of what Schroeder calls "...lack of firm leadership, political support and external demands on its services." [58] By 1854 Congress, seeing a new role for the Navy in commerce protection and diplomatic expansion, demanded to know the status of all steam warships and their cost. They required the Secretary of the Navy to produce names, conditions of, costs, armaments, and speed of each steam warship built since 1835. The subject of a steam Navy was being hotly debated.[59] Not until 1858, well after steam technology was readily accepted by most naval and civil leaders, was the tactical signal book of the United States Navy updated to include steamship signals.[60]

Naval Expansion

As early as 1842, Secretary Upshur, realizing the diplomatic and political possibilities in the Pacific Ocean, was convinced that a viable naval presence was needed to curb British control of the Pacific rim.[61]

By the 1850's American commercial interests in the Pacific rim were expanding at a tremendous rate. Expansion of Pacific trade routes by the merchants of the Eastern seaboard demanded, as it had on the Atlantic forty-five years earlier, that a credible naval presence to protect shipping be provided. In 1845 President Polk opened relations with China by use of the United States Navy's Asiatic Squadron.

Between 1849 and 1860, American foreign trade increased 144%, from $281 million to more than $687 million.[62] During this period the Navy built thirty-three steam warships with a strategic role of protecting commercial and diplomatic interests overseas.[63]

Improvements in steam technology during this decade, although arguably not as significant as with the previous decade, included the compound-reduction piston engine--which increased the power of steam engines tremendously--and the iron warship. The exploding shell gun, proven in trials ashore and at sea during the 1840's, dictated the improvement of armor plating in warship design. This was brought to the forethought of the civilian leadership in Washington when they received word of the destruction of a Turkish naval squadron in Sinope in November 1853, by a Russian squadron. As Admiral Robison argued, this incident gave the entire world a lesson in the efficiency of shell fire.[64]

The ironclad warship was just becoming state-of-the-art in the late 1850s. Although Britain and France had fully developed the technology of iron framing for warship design, the United States, with its vast reserve of timber, felt that this step was not necessary in the evolution of the steam warship. It wasn't until the production of the *Monitor*-class warship in 1861 that Union forces accepted the viability of an all iron hull.

These developments--steam propulsion combined with ironclad warships and shell guns--would revolutionize naval warfare during the period of this study. Technology played a significant role in the tactics, strategy, and political arena the United States found itself during these times. Sir Howard Douglas, eminent naval tactician in Victorian England, would say it best:

when that [steam] . . . power shall be applied to . . . ships . . . naval evolutions will be capable of being executed with the utmost precision . . . . We cannot fail to be convinced that distant firing [of naval guns] will be the ruling practice on which success will depend.[65]

CHAPTER FOUR

THE STRATEGIC AND OPERATIONAL ART

THE EARLY YEARS, 1816 - 1830

As seen in the previous chapters, the early years of steam technology development was punctuated by slow, determined progress by a few farsighted individuals. Bernard Brodie said that, after the war of 1812, Americans weren't willing to foot the huge bill required to advance the Navy technologically. "Peacefulness of the times tended both to preclude concern over new weapons of war and to lessen interest in their development."[1]

In 1816 Congress authorized the President to acquire engines and other materials for constructing steam-propelled "floating batteries."[2] The idea was that the floating batteries would be able to steam to the various ports that needed defending on the Eastern Seaboard and defend a threatened harbor. This affinity for floating batteries pervaded the senior naval leadership and Congress well into the 1830s. We do see a vocal minority led by Matthew C. Perry, who saw very little utility in the purely defensive nature of a floating battery.

Congressional fear of another invasion of the same form as in the War of 1812, and the utility seen in floating batteries effectively stifled any serious consideration of steam being a prime mover of warships well into the century. The expense of these batteries--well over 300,000 dollars in 1816--was so prohibitive to the new republic that, although approved for construction, they were never built. The Navy's penchant for a "blue water" force rather than a "brown water" one ran head-long against Congressional desires to provide security for the port facilities of a voting public--a mission the Navy always felt was in the purview of the United States Army Coast Artillery Corps.

With the advent of peace and the perceived vital interests of the United States returning to its own shores, a period of naval retrenchment followed. The Secretary of the Navy, once a position reserved for seafaring men--by definition an expert in the art of sail--was now a political appointee. Benjamin Crowninshield under President James Madison was the last Secretary to have sail experience. The office would, thereafter, be occupied by lawyers, statesmen and businessmen.[3]

Crowninshield was given direction from the President to move the Navy from a wartime to peacetime footing. During this period of downsizing, President Madison was given fodder for his cannon by the successful suppression of the Algerian pirates in the Mediterranean. This successful campaign was held by the administration as a banner indicating that the Navy could do more with less. The long term effects of this campaign were to demand a larger force.

With the suppression of the pirates, the Navy formed the Mediterranean squadron as the first permanent United States naval force deployed overseas. This squadron has never gone away and is known today as the Sixth Fleet. The Navy was a victim of its own success. As successful operations were conducted with less money, President Madison felt that his aspirations for a leaner naval force were justified, especially considering the shrinking federal budget and the general economic depression throughout the economy.

After the 1812 war, the administration saw no utility in the use of steam. The senior naval leadership was entrenched in the use of large sailing warships as the *guerre de course*. It is then paradoxical that we see the first strategic use of naval forces for other than direct combat during this period. Crowninshield ordered the naval captains to assist the State Department by transporting diplomats overseas and acting as a "show the flag" arm of diplomacy.[4]

With the new peacetime mission of diplomacy from the sea, the Navy was forced to develop squadrons in the Mediterranean and also in the West Indies and the eastern Pacific. The West Indies squadron's mission in these early years was to protect American commercial interests in the area and to suppress pirates.[5] In the Pacific, American interests were expanding a span of influence south in to South America. During the early years the Pacific squadron was only activated temporarily for specific missions.

It can be seen that the influence that steam propulsion had during these early years was slender at best. The cause of this lack of attention can be divided into two basic categories: technological and sociological.

Technological and Social Change

Although the "radicalism" associated with the proponents of steam propulsion was being heard throughout the Congress, the negatives that steam brought to the Navy were yet to be answered by the advocates. How do we protect our gunner's mates from steam when a shell destroys the propulsion plant? Recall that because of the technology of the time, the steam boilers and engines were located high on the ship, usually on the weather decks where they were exposed to the hazards of naval battle. The method of propulsion, a paddle wheel, required direct connection between the engine and the wheel. The only way to accomplish this was to collocate the machinery on the main deck with the axis of the paddle wheel.

Congress and senior naval officers felt that this situation was too dangerous and that steam would only be good for e ergency propulsion. The retrenchment felt throughout the bureaucracy was stifling the advancement of steam technology. If it hadn't been for the development of the screw propeller and the exploding shot naval gun, it would have been a much less capable Navy.

Early Technological Advances, 1830-1842

The Screw Propeller

In 1836 the First Lord of the Admiralty of Great Britain accompanied a young Swede named John Ericsson while he towed the barge containing the First Lord at a speed of ten knots on the Thames River. The First Lord decried the propeller, saying that any vessel moving that fast with a screw propeller at the stern of the vessel would render the vessel absolutely unsteerable.[6]

As discussed earlier in this thesis, in contradiction to the pessimism displayed by the British, U.S. Navy Captain Robert Stockton funded Ericsson to travel to the United States where he assured Ericsson that the federal government would be sure to fund his experiments.

In 1843, after Matthew Perry had convinced Congress that steam propulsion did have a place in the future of the Navy and the successful trials and use of the steamships *Mississippi* and *Missouri* (and strong lobbying by Stockton), Congress authorized the construction of a steamer which would be fitted with the Ericsson propeller.

The nature of the screw propeller that proved so successful on the *USS Princeton* was what made it successful in future warship design. Through its simple design, the screw propeller allowed the propulsion plant to be placed within the protection of the hull. Low in the hull, the plant would be protected from shot. Also important to the technological revolution was that removing the machinery from the gun deck meant that there would be room for more guns and more firepower. This then allowed the modern steam ship to look like her sailing ancestors where the gun deck was cleared of all unnecessary gear except guns.

The *Princeton*'s success was readily apparent to those in Congress, in spite of the tragedy on its voyage to the nation's capital. Still, there were those in Congress who were skeptical. After all, the cost of the *Princeton* was tremendous during those times of budget constraints--$212,615.00. Just as it is difficult to convince Congress that it is wise to invest in new technology today, it was difficult for the proponents of steam propulsion to do so in the time of Ericsson and Stockton. However the *Princeton*'s success was not limited to the screw propeller. As indicated earlier there were two technological changes that provided impetus to the steam ship program. One was the propeller, and the other was the shell gun.

The Shell Gun and Iron-clad Hull

The Paixhan gun, developed by French General Paixhan, was the first significant advancement in the naval gun (cannon) in many decades. Until this gun was introduced in the United States Navy--once again promoted by Captain

Stockton--the Navy relied on the solid and grape shot that had been used for what seemed centuries. The Paixhan gun allowed the shell to penetrate the hull of enemy warships and then explode, wreaking havoc and mayhem on the gun deck of the enemy. This very development caused the change of warship design to the iron-clad, armored hull.

A wood hull would not go away for many years, but a wood hull sandwiched between iron plates countered the exploding shell that could penetrate a wood hull. The guns mounted on the *Princeton* were of the exploding shell type. However, with the tragic explosion of one of the guns, the United States ceased experimentation for quite a long time. It is because of this tragedy that Navy Lieutenant John Dahlgren was given license to improve the shot gun that would prove its worth during the Civil War.

This did not stop Europeans from continuing research, however, and significant advances were made in both steam propulsion and exploding shell guns in both France and England. In fact, both France and England began a "steam fleet" building program, where the Committee on National Defence, comprised of the Secretary of State for War, Commander in Chief, Master General of the Ordnance, and the Inspector-General all recommended that additional funds be released due to the fact that Britain feared an invasion by the French Second Republic, to be spent on fortifications and steam machinery, rather than 10,000 extra troops.[7]

By 1852, the Surveyor of the Navy in Britain decided that the period of experiment with steam had ended and proposed a long term program of construction and conversion to an all steam battlefleet.[8]

In America, there was not a great use of this particular new technology during the time period of this thesis, however a technological advance in the placement of the guns would prove to be the future of naval gunfire. The *Princeton* would mount two main guns centerline on the ship. That is the guns would be able to be trained on either the port or starboard side of the ship and engage any enemy simultaneously. Admiral Robison's comment about the symbiotic relationship of technological advancements at the time was:

> It may fairly be said that when the steam era was well established, movable sights graduated in degrees had superseded the line of metal as a means of aim; that ranges greater than point blank were being considered as the caliber of guns increased; that shell, as well as shot, were supplied to broadside and larger guns; that rifle vs. smooth bores were being considered; that iron for hulls had its advocates.[9]

In the United States Navy, many would fight the improvements shown to exist by current technology and, even through the Mexican War, continue to resist the advancements. It would not be until just before the outbreak of the Crimean War that we would see the spectacular results that the new technologies would have during battle.

Both the Russian and Turkish Navies had steamers. The difficulty lay in the tactical use of these steamers. During the Battle of Sinope in November of 1853, a Turk squadron including one steamer came against the overwhelming force of a Russian squadron with no steamers. Vice-Admiral Nakhimov, with a force of three 84-gun warships, three 120-gun warships, and two frigates, brutalized the Turks. Only the Turkish steamer was able to escape. The key to the Russian success was warships with exploding shell guns.[10] The United States was apparently oblivious to the findings of the Crimean War, however, and pursued an agenda quite removed from that of Europe.

Returning to the pre-Mexican War United States, the technologies of steam propulsion coupled with screw propeller and advancements in naval weaponry would irrevocably advanced the Navy forward. It is certain that the steam warship gained new advocates, however their enthusiasm was held in check by conservative public officials who valued a policy of retrenchment for the Navy.

From 1830 to 1845 the Navy's principal duties included protection of the citizens and commerce in foreign ports and seas. There was no perceived need to develop a steam navy. This attitude, coupled with a reeling economy, caused President Martin Van Buren to say "This country requires no Navy at all, much less a steam Navy."[11]

This led to the mobilization of those who felt that steam was the way of the future. Such men as Matthew F. Maury--who would be the first officer in charge of the Naval Observatory--, Alexander Slidell Mackenzie and his brother-in-law Matthew C. Perry, and certainly Robert F. Stockton. These men perceived a threat that most could not see: the stagnation of their Navy in the technologies of the past, while their potential enemies--Great Britain and France--were constantly improving their navies.

Although, as Barbara Tomblin wrote, by the mid-1840's the United States was building the most advanced warships in the world, the Department of the Navy failed to capitalize on these advancements. As the American Navy languished in the advancements of the past, the French and British carried on tremendous experiments with all the new technologies, taking well over a decade to perfect them, albeit more from fear of attack from one another than any altruism.[12]

It was just during this time of confusion in the national direction that a key development in the advancement of steam technology was made. For years Matthew Perry had been arguing for a professional Engineer Corps that would oversee the development of the propulsion plant. In 1842, Secretary of the Navy Paulding authorized the creation of the Naval Engineer Corps under the Chief Engineer of the Navy Gilbert Thompson.[13]

Concurrent with the new Engineer Corps was the disestablishment of the Board of Navy Commissioners and the establishment of the Bureau system that survives to this day. Under the tuteledge of Abel Upshur, who established the Engineer Corps, Congress authorized the bureau system.[14] With the establishment of the Bureau of Construction and Repair, the steam advocates finally had an ear of the highest order.

During the early bureau years, according to Oscar Paullin, the principal works of the bureau were the construction of a steam fleet, improvement of personnel, operations of exploration and, lastly, the conduct of the Mexican War.[15]

From 1845 to 1860, we see that the shift to steam propulsion had irrevocably begun. The number of sailing warships on active duty decreased from fifty-nine to forty-four. Conversely, the number of steam warships increased from six to thirty-eight. Most of these changes would occur after 1854.[16] This can most likely be attributed to the fact that steam propulsion was seen as a viable advancement after the Crimean War. This is apparent after the Anglo-French operations in the Baltic and Black Sea, and the Mexican War. In the Baltic and Black Sea, under the inspiration of Louis Napoleon, "floating batteries" armored against shells fought at anchor where they would pound the defenses on land int. submission. There advantage was that they could not be harmed due to their armor and angled sides.[17]

The Mexican War and Technology

Although many argue that naval warfare conducted during the Mexican War on both the Atlantic and Pacific sides of Mexico was inconsequential, it can be argued that the type of naval warfare seen in the Mexican War had just the opposite effect. The significant use of steam warships was the first such use by any nation until the Crimean War. Everybody knew that steam technology would revolutionize naval warfare; the problem was that the tactical doctrine hadn't been written yet. No one knew quite how to use this technology within the framework of naval warfare.

The acquisition of California and New Mexico, the discovery of gold in California, and the increased commerce by the merchants of the United States in the Pacific led to a required permanent presence by the United States Navy in the Pacific. As tensions grew between Mexico and the United States, warships were sent to the Gulf of Mexico--part of the Home Squadron under the Command of Commodore David Connor--to ensure the freedom of navigation of United States commercial vessels.

The prime objective of the U. S. Home and Pacific Squadrons during the entire conduct of the Mexican War was prevention of interference with American trade and support of the land forces. The American Navy, never one to take the boring jobs, was relegated to a role of blockade. This duty was certainly against the wishes of most of the officers and seamen, as they were raised to think of the Navy as conducting pitched battles with an enemy on the high sea.

This boredom would be held in check by naval brigade duty, putting sailors ashore to act as infantry, and by excursions up the various rivers to seize selected towns.

Steamships were used for the shallow waters of the Tampico and Tabasco river operations because the deep draft men-of-war couldn't rely on the winds, tides, or current in the treacherous waters. It is interesting to note that although the steamships played a significant part in the operations, they still were a small portion of the Navy operating around the coast of Mexico. Out of the sixty-two warships that would eventually participate in the Mexican War, either attached to the Pacific or home squadrons, only thirteen were steamers.[18] Of the fifty recorded naval engagements, all of them entailing some sort of land action on the part of the squadron, twenty-four of them involved a significant number ofthe steam ships in theater.[19]

This figure is a significant one. Although the steamers made up only about twenty percent of the force present, they accounted for almost fifty percent of the engagements. This can be attributed to the fact that

Matthew C. Perry, that strong advocate for steam power, was assigned as commodore of the Home Squadron half way through the war. This unusual move allowed Perry to use the ships he so desperately wanted to use for the purposes for which he felt they were best suited.

An example of the use of the steam warship is seen in the second expedition up the Tabasco River to seize control of the city of Tabasco in June 1847. The objective was to capture the town so that the Tabascanos could not support the flow of supplies to Santa Ana's army. At first Commodore Perry felt there was little to be gained by the expedition, but he went ahead with it just the same.

Once at the Tabasco River bar, the flagship *Scorpion*, with Perry onboard, towed the ships *Vesuvius, Washington*, and the boats from the steamer *Mississippi* (the *Mississippi*'s draft was too deep for the bar) and *John Adams*. The steamer *Spitfire* towed the *Stromboli, Bonita*, and the boats from the *Albany*. Finally, the steamer *Vixen* towed the boats from the *Raritan, Germantown* and the *Decatur*.[20]

The mission proceeded cautiously up the river until success was met at the city of Tabasco. It was because of the steamship that the conduct of riverine warfare was so successful. Considering that most rivers in Mexico were shallow, with fairly significant currents, and that the wind was light and variable for most of the year, this operation would not have been tried had it not been for the steamship. The operations of the Mexican War are replete with examples of the invaluable service of the steam warship. American naval officers gained significant experience and realized a great potential for the use of steam warships in "joint" operations including blockade duty and tactical operations in the "brown water" environment, although they felt the "blue water" capabilities were paramount.

The logical question to ask is what developments occurred because of the Mexican War. Most importantly, the Navy now saw a role in the conduct of amphibious landings. The naval brigade established by Commodore Connor, completely self-contained once ashore, met with tremendous success in the operations conducted. Used on nine separate occasions, the naval brigade met with unique success and was used by Perry once he took command of the squadron.[21]

The effect that the steam warship had on the conduct of the war was evident to all. The question remains that, since steamships did not conduct offensive operations against an enemy at sea, would they perform to the standards expected by a sailing warship? Based on the experience of the United States Navy during this war, many--including Matthew Perry--thought that the steamship would have significant import on the conduct of "blue water" operations. The problem was that the proponents of a steam Navy couldn't prove it to a skeptical Congress.

Certainly, as the war was ongoing, Congress saw the expediency of using steamers for blockade duty and riverine warfare. The Naval Appropriations act of 1847, which authorized the construction of four steamers for use in the Mexican War, is an example of their perceived need. Congress' view was myopic to a fault.[22]

The four steamers built under the appropriations act--*Susquehanna, Powhatan, Saranac*, and the *San Jacinto*--would all gain fame during the Civil War in various operations. They were large (ranging from 2,200 tons to 3,824 tons), and relatively well armed. Bauer argues that these ships were built only as a stopgap measure because of the success of steamers in the Mexican War and a significant lack of them in theater.[23] This seemed to make little difference with the Navy brass as, by 1849, there were only seven ocean-going steamers, four of which were not completed![24]

Lieutenant Raphael Semmes, who would gain fame as the dashing commanding officer of the Confederate raider *Alabama* during the Civil War, was in command of one of the small steam schooners purchased for the Navy from a private contractor. In his book regarding the conduct of the war he wrote,

> The Vixen was an important acquisition to the squadron, as previously to her arrival we had sadly felt the want of small vessels, and particularly of steamers. A predatory warfare along the coast, was all that we could hope to carry on; and for this purpose our heavier vessels were entirely useless.[25]

It is an unfortunate circumstance that the United States, as in so many cases in the past, would not learn the lessons of its younger military officers--that steam power played a decisive role in the conduct of the war--and failed to recognize that a significant shift in naval warfare was occurring. The Mexican War failed to change the basic *Guerre de Course* philosophy of Congress and the Navy Department.[22] These bodies still recommended that the sailing vessel be the primary warship in the United States Navy.

Change was evident because although the ships built for the Navy immediately after the war from 1849 to 1853 were few, they were the largest steam warships to date. The largest was the *USS Franklin*. Weighing 5,170 tons, she was 265 feet long and cost an astonishing $1,331,000![23] Although classified as a frigate, she was more on the lines of a European battlecruiser. The *Franklin* was still in service at the end of the century as a receiving ship in Norfolk, Virginia.

What is seen today of the American experience in the Mexican War is the antithesis of Alfred Mahan's great vision of what the steam warship would provide. It would not provide, with few exceptions, the "Nelsonian" battle so well thought of. Rather it would provide the genesis of the operational art in naval warfare. Tactical operations in a specific theater of war--none of them taken by themselves would provide strategic results--when combined would, however, have strategic significance.

Commercial Influence

Throughout the early development and employment of the steam warship, commercial shipyards were the prime contractors for steam warship construction. The Navy yards then in existence had little or no experience at construction and emplacement of steam equipment. In fact, it wasn't until 1839 that machinery for a steam warship was constructed by a government yard. That was for the steamship *Missouri*.[24] "The Navy," argues Tomblin, "tended to avoid the risk of technological innovation by relying upon private industry to develop new vessels."[25]

Throughout the early years of steam development, civilian firms designed and built the new machinery that would propel the Navy into the future. *Fulton II*'s machinery was constructed by the West Point Foundry, as was the machinery for the *Missouri*.[26]

In fact, so important was the ability of the private constructor to the development of the Navy's steam warship, that Tomblin credits this superb relationship as playing the decisive factor in the Union Navy's victory over her southern cousin.[27]

Between the years 1854 and 1859, the Navy constructed twenty-three steam warships, only three of which were fitted with machinery constructed in a government yard.

Such notable yards as Merrick & Town in Philadelphia worked closely with the U.S. Navy Yard across the Delaware River. Other notable yards were the Union Iron Works in San Francisco and the Morgan Iron Works in New York City.[28]

This symbiotic relationship between civilian constructors and the Navy's technological development has continued to this day, where ships are built in private shipyards.

Diplomacy

As America's eyes turned westward during the 1850's, so too went it's Navy. The years after the Mexican War proved to be a sort of rebirth for the U.S. Navy. The development of steam propulsion had opened new doors for the service in the Pacific. The winds that once kept mariners tied to the trades were no longer a factor and, with this new found freedom, the federal government took full advantage of the new technology. In November 1852 Matthew Perry got underway from Norfolk, Virginia with the steamers *Mississippi, Susquehanna*, and *Powhatan*.[29]

Perry and his entourage entered the Bay of Yedo (Tokyo) on 8 July 1853 with a letter from the President to the Emperor of Japan regarding the opening of diplomatic ties.[30] In short, the treaty provided for wood, water, provisions, and coal. This allowed commercial and naval vessels to trade freely with Japan and assure themselves of the necessary provisions for the steamship.

Because of the new-found use of the Navy and the steamship as a tool of the government, diplomatic use of Navy steamships increased throughout the decade preceding the Civil War. One Secretary of the Navy was directed by Congress to start a mail and steamer route from San Francisco to Canton, China using four steam warships and one large steamer. Another proposal was to set up a steamship/mail line from Hawaii to California.[31] Wisely, Congress never approved this proposal for lack of funding resources. Use of naval vessels in this capacity opened a public debate and generated much enthusiasm for the diplomatic and commercial uses of the steamship Navy during peacetime.

The steamship had gained a permanent place in the commerce of the nation. Tonnage of ships entering and leaving American ports increased from 5.4 million tons to 12.1 million tons.[32]

> The increase in American trade, the new Pacific coastline, the need to safeguard the flow of gold from California, the necessity of protecting the isthmian route, and the nation's burgeoning Pacific interests demanded a western naval base, an increased naval presence in the Pacific, and new principles in the formulation of American peacetime naval policy.[33]

In 1849, Secretary of the Navy William B. Preston recommended that an American steam Navy be made a permanent addition to the Pacific.[34] Congress was still not impressed and failed to include additional steamship construction in the budget above the ships already authorized.

Although the die had been cast and steam warships would be a part of the American Navy from then on, there was still little expertise on their employment in battle. The question was still what would happen when two steam warships met in pitched battle. No one in the American Navy had seen this occur, and Congress was certainly no help. The battle between Russian warships and Turkish frigates in 1853 was the first recorded battle at sea involving a steamship, but the American Navy--and certainly Congress--paid little attention to the ferocity with which warships armed with shell-firing guns were to fight.

> Apparently oblivious to European advancements in ordnance and naval architecture and to the importance of capital ships during the Crimean War, Senator Mallory spoke for most of his colleagues in 1858 when he averred that the nation should hold fast to the policy that enabled the navy to achieve glory during the War of 1812 when 'frigate was matched against frigate, sloop against sloop, and brig against brig.' This was the legacy bequeathed Abraham Lincoln and Gideon Welles by the leaders of the antebellum navy.[33]

Before the Civil War decimated the country and divided her citizens, the American Navy was certainly behind the times in terms of steam technology and its application in conjunction with other technological advances in ordnance and naval architecture. In fact, it wouldn't be until the Civil War that true engineering techniques would be used to discern the subtleties of steam propulsion.

Although the period of the Civil War is beyond the scope of this thesis, it should be noted that it was because the Union and Confederate Navies were able to produce steamships in large quantities (mostly the Union) they were able to exploit the technology to their advantage. The Civil War would be the proving ground for steam propulsion much as the Gulf War was the proving ground for "smart bombs" and "cruise" missiles such as the U.S. Navy's Tomahawk missile.

One-hundred-sixty-four steamships were built during the Civil War, seventy-six of them in 1862 alone.[35] The steam powered warship had found its home after all.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

The previous chapters of this thesis outlined the effect that steam propulsion had on the young Navy of the United States. The growth of this technology was slow and monotonous; however, it was crucial in the development of our nation and its ability to provide protection for its burgeoning commerce.

The stratification among the tactical, operational, and strategic levels of war are rather hazy, but some differentiation can still be seen among those levels and how they apply in the case of steam technology in the first half of the eighteenth century. The majority of the time the difference between the tactical and operational levels are fuzzy; however, the strategic implications of steam propulsion as it applies to the eighteenth century are not.

With the conclusion of the Crimean War in Europe and the Mexican War in the Western Hemisphere some subtle implications regarding the operational level of war are apparent. Although the "Nelsonian" battle in the tradition of Trafalgar and the Nile are not seen, what is seen is the genesis of the operational art--leading to a definition of operational warfighting in the nineteenth century. The mere fact that a series of tactical battles in the sense of amphibious operations in Mexico and small tactical engagements between warships in the Crimea all lead one to see that it is a series of tactical engagements that creates the environment for strategic success.

There is not one decisive battle in either of these wars that results in a strategic victory, however the series of naval engagements documents that through many successive engagements in a theater campaign a nation can achieve a modicum of strategic success--or rather lead that nation to conditions whereby strategic success can be gained. This series of documented engagements, in the authors view, is the operational level of naval war in its infancy. But what significance did the introduction of steam technology have in providing the catalyst to the development of naval operational art?

Changes occurring because of the implementation of steam propulsion, according to Bernard Brodie, can be divided into three distinct areas. First, changes in performance (i.e., speed of steamers versus speed of sailing warships); second, the necessity of a reliable fuel source; and third, modification of the geographic relationships of nation-states. Brodie argues that because number two--fuel source--caused limits to where the fleet could go, all steaming nations competed for the same fuel. His arguement is that this promoted conflict.[1]

This reasoning is accurate in the author's opinion. Sail warfare relied on the wind--its character always determined how or when a battle would be fought--and this was more chance (or luck) than a reliance on any skill. This is not to say that the captains of sail warships were not master tacticians in their own right, but with the advent of steam propulsion the wars were fought on "neutral" turf, i.e., the playing field was now evened out. One steamers speed varied little from her enemy's speed. The weather had little effect on the maneuverability of the vessel (other than extreme weather). Brodie contends that steam introduced a certainty and precision into the movements of the fleet. Steam power made the art of naval warfare possible.[2]

To say that steam propelled warships were not limited is false. Steam warships were more limited, on a strategic level, from the limitations put on them by their own people. The Navy, prior to the Civil War, refused to allow steam warships to be built without masts and full sail rigs. In fact there was not a Navy in the world that allowed steamers on the high seas without the ability to rig full sail during this time.[3]

Steam's Strategic Effect

Although the introduction of steam propulsion into the commerce of the nation (for that matter all nations) caused shorter lines of travel between ports, it had a negative effect on the operations of a naval fleet. With the introduction of steam warships, the combat radius of warships was drastically reduced.[4] As Bernard Brodie put it, "Sailors could go on half rations, boilers can not."[5]

A significant point must be brought out at this time that runs counter to this thesis. Although steam would have significant effect in the tactics of the Civil War in the United States--tactics would be reviewed over and over again during that conflict--*no one understood the tactical import of the technology in a quantifiable manner.* Certain individuals, such as Perry and Maury, understood that steam would eventually play a major tactical role in modern warfare, but they were few in number and had no experience in fighting steam warships at sea.

It is interesting to note that although the American military had no real understanding of the tactical and operational importance of the technology, they still spent millions of dollars (in current year dollars) investing in it. This paradigm, the author of this thesis believes, is still true today. Through the insight of a few forward-thinking idealists Congress is willing to invest in a weapon (such as Tomahawk) that has not proved its worth in combat.

In his treatise, Naval Strategy, Alfred Thayer Mahan writes,

> . . .while steam has facilitated all naval movements . . . it has also brought in the element of communications to an extent which did not before exist. The communications are . . . the most controlling feature of land strategy; and the dependence of steam ships upon renewing their limited supply of coal, contrasted with the independence of sailing ships . . . is exactly equivalent to the dependence of an army upon its communications.[6]

Mahan also says that steam had yet to prove itself and that ". . . steam navies have as yet [1891] made no history which can be quoted as decisive in its teaching."[7] Even the great theoretician Mahan saw that the use of steam technology, as late as 1891, had not really been used to a point where new strategic thought could be applied. It is not until after World War II that Americans take a hard look at naval operational art, even though--as seen in Mahan's writings--they were able to discern the strategic implications rather quickly. It is, therefore, reasonable to say that steam technology prior to 1860 was so in it's infancy that it had little effect on the tactical/strategic thinking of the nation and therefore the study of naval operational art.

This is not to say that strategic/tactical implications were not evident. Perry's use of steamships in the riverine warfare of the Mexican War for example; however, general naval thought did not include the tactical revolution--and little, if any, connection was made to the operational level of war--that steam would provide two generations in the future.

Another strategic implication about the introduction of steam technology to warship design and employment is the necessity to conduct machinery repair. Steam warships requiring repair could go to more distant ports than their sailing cousins and return more quickly to the theater. This eliminated the long off-station times that sailing warships were prone to when materiel requirements necessitated their leaving the theater of operations and travel long distances by sail.[8]

<u>Steam Propulsion's Global Effect</u>

Throughout the first half of the nineteenth century, America was expanding it's horizons in a swiftness which was never to be repeated. Cries went out to all citizens to support commercial enterprises wherever they were. Where did this leave the United States Navy? How did this commercial expansionism, energized by the commercial use of steam propulsion, affect the global economy and the navies of the world? This question should be more fully explored in any follow-on research that is done in this field.

To say that steam propulsion profoundly affected the commerce of the nation, and thus the Navy, is rather simple. The body of this thesis shows that the commerce of the nation significantly affected the development of the Navy.

Steam propulsion, initially supported by the civilian sector, was slowly introduced into the United States Navy. Technology was not the friend of the nineteenth century sailor the way it is to his twentieth century shipmate. In reality it was not during the period of this thesis that the Navy appreciated the implications of steam propulsion. Mahan felt that steam's potential had yet to be realized forty-five years after the Civil War.

Steam power enabled commerce (and the commerce raider) to transport goods without heed to the wind or tide. Distances once thought too great for the sailing ship to economically transit for the transport of goods were suddenly within reach of the steamship. The shrinking of the lines of communication and the subsequent need for fuel depots in the form of coaling stations caused cultural clashes that would lead to significant strife later in the 20th century. By 1855 the United States used coaling stations in Japan, Formosa, Port Lloyd in eastern Russia, and China.[9]

The lack of such coaling stations would send the Russian fleet--along with its most competent seamen--to its grave during the Russo-Japanese war.

> His [Admiral Rozhestvensky] difficulties of supply, and chiefly of coal, are known; the most striking consequence is the inconsiderate manner in which . . . he stuffed his vessels with coal for the last run of barely a thousand miles. That he did this can be attributed reasonably only to the impression produced upon his mind by his coaling difficulties. . . . this injudicious act . . . put his ships in bad condition for a battle . . . .[10]

These tragic losses by the Russian Navy would be felt for the rest of the twentieth century.

The effect of not having coaling stations loomed ominous in the minds of the forward thinking Perry, et al. Perry, contends Brodie, concerned himself--as the sole diplomat in the Far East--with the broad strategic goals of the Pacific Basin based on commercial enterprise.[11] This is significant, as the United States found itself in a position of empire building. This new requirement laid on diplomats by the steam Navy had significant and obvious strategic implications.

As seen in this thesis, steam propulsion could not accomplish the modernization of the Navy as foreseen by Perry and his contemporaries alone. This required the synergistic effect brought on steam technology by the introduction of the exploding shell naval gun and the screw propeller. Only with these new technologies working together was the desired effect of technological change accomplished.

Concurrent technological development in Great Britain, France, and Russia seemingly--with the exception of the fear that some isolated naval officers felt--went unnoticed in the United States. As mentioned, the strategic implications of the tactical victory by the Russian fleet against the Turks at Sinope went virtually unnoticed in the United States. This is, of course, partly because of the impending rift between the Northern and Southern states of the Union.

It should not be surprising, however, that this battle was not studied by the naval officers of the time. The myopic view held by most influential Americans regarding the necessity of a strong military seemed to portend ignorance of strategic implications. This, coupled with lack of professional education on the part of the Navy (the

Naval War College wouldn't be established for almost twenty years after the Civil War), was indicative of the lack of interest in the military and political climates around the world.

Steam Propulsion and Technological Change

> Change roughs up people by disrupting accustomed ways of doing things and redefining power relationships within societies. . . .[12]

It can be argued that the only way to convince someone that technological change is good for them is to prove it. This appears to be the logical conclusion of how Americans view technology and its advancements. Americans are at first reluctant, as a society, to use new technology. This can be viewed in a certain "Orwellian" perspective. Cautious for fear of "Big Brother" intruding into their lives, Americans hesitate to use new technology to their advantage until it is necessary. Merritt Roe Smith's argument that change disrupts power relationships within a society can be related to this view. It is only forceful personalities, argues Smith, that greatly influence technological change.

Pre-Civil War society was unwilling, in general, to view technology in a positive light. Society "placed a check on the idea of progress due to a reverence for antiquity."[13] We can view a pattern over time, argues Elting F. Morison, that appears to be consistent no matter what technology is analyzed. An overarching consideration for social/political interactions can be seen. These interactions take place at the very initial stages of technological innovation.

Morison argues that there are certain stages of response to technological innovation. First, no response. In other words, the technological innovation is ignored. Second, there is a general attempt to discredit the innovation with "logic" as perceived by society's current "norms." Third, and this is where it almost always ends up, is name-calling. Those persons desiring a continuation of the status-quo end up deriding the innovators, usually because of the tenaciousness with which the innovators pursue their innovations.[14]

The confusion arising from the introduction of steam propulsion into the Navy can be no better summed up than by Morison when discussing Charles Haswell's introduction into naval society at age twenty-seven as the first Naval Engineer.

> When Haswell was the only Engineer in the Navy and the first to go to sea, no one knew where to put him in the ships company. After a good deal of debate, it was decided that he should dine in the wardroom . . . because he seemed a man of some background and his father had been a member of the British diplomatic service . . . .[15]

So confusing was the introduction of steam into the Navy that not even the officers in the Navy knew how to treat the technology or its engineers. Acceptance of the new technology meant believing that an acknowledged body of experts did exist.[15]

This was a hard pill for professional naval officer to swallow. Professionalism at sea meant that a young officer was trained at sea, not in a classroom or laboratory. Buhl argues that it wasn't until certain circumstances were met that steam was fully accepted by the Navy. This included the establishment of the Engineer Corps, development of the bureau system, and appointment of an Engineer-in-Chief from the ranks of the Engineering Corps after 1845, instead of a political appointment.[17]

What is seen in this example is the first instance of divisiveness in the naval officer Corps. This occurred, in part, because of the uncertainty of the new technology. It wasn't until the Engineer Corps was disestablished in the late nineteenth century that specific reference to the previous divisiveness was no longer apparent.

Lessons Learned

What can be learned from experiences in the advancement of new technology? It can be seen that social, political, and economic realities fight against the introduction of new technology into society. A cry for reorganization, on the surface a truly honest move at reassessment, can portend near disastrous results in future combat. The United States Navy was woefully unprepared to conduct blockade and riverine warfare at the outset of the Mexican War because of a lack of resource allocation for new technology. What about the old adage that "the proof is in the pudding?"

A final argument, and possibly the most convincing, is that no matter how technology is assimilated into a society, it is not readily accepted until held to task by operational performance. Although the Mexican War showed the inadequate preparation of the federal government to conduct sustained operations at sea, it did, in part, substantiate the requirement for steam warships. They would become a significant asset to the naval commander. The percentage of steam warship construction versus the construction of sail warships was increased dramatically after the war.[18]

> It is their [those arguing for continuation of an older technology] job to prove that this argument is fundamentally unsound . . . . The consequent debate can be resolved when it really comes down to it by nothing short of direct operational experience . . . .[19]

Throughout the 1830s, the United States Navy was involved in experimentation with steam propulsion that would reap great benefits in the Mexican and Civil Wars. Individuals were the key to the slow but consistent growth of the technology, punctuated by economic and diplomatic necessities requiring the Navy to take on new roles and missions. Matthew Perry's expedition to open diplomatic, economic, and hence strategic, ties with the Empire of Japan--demanded by extensive commercial activity in the region--forced the Navy to maintain a modern and efficient squadron in the Pacific.

By the 1840s, the Navy was combining the existent steam technology with other advanced technologies in gunnery and propulsion. It is important to realize that steam's use was catapulted forward by the catalyst provided by these other technologies.

The real tactical problem facing senior naval officers was one of vulnerability of the propulsion plant, coupled with the inability to mount significant firepower because of the location of that propulsion plant. This severely limited steam's usefulness. Until those issues were resolved by the introduction of the shell gun and the screw propeller, steam propulsion stood little chance of being anything but a sideshow in technological advancements.

The Mexican War proved to be a watershed event in the first half of the nineteenth century and changed the face of American naval warfare. Steam warships were used in significant ways to further the economic and strategic environment in the Gulf of Mexico and the Pacific. Riverine warfare and blockade duty were the significant tactics where steam warships were employed. Steamers were used as towing vessels up the various rivers of Mexico and, as seen in Lieutenant Raphael Semmes' accounting, were particularly suited for the blockade duty of that war.

By the end of the Mexican War, and throughout the 1850's while the United States was attempting to resolve key states' rights issues, the Untied States Navy was pursuing the development of "blue water," steam powered warships. The technological synergism realized by the combination of screw propeller, steam propulsion, and shell firing naval guns, coupled with advancements in ironclad designs late in the decade, led to the successes of the Union Navy during the Civil War.

Steam technology's significant influence on the strategic level of war is fully supported by the research conducted for this thesis. What is less clear is the effect that steam had on the operational level of war. As noted earlier, the first real beginnings of the operational art can be seen in hindsight; however, we can never be sure that those living in the times could identify such a distinction. Clearly, the fact that steam warships could transit theaters rapidly and with less concern about the influence of nature played a significant role in the increased interest in development after the Mexican War. What about before that war?

In a negative light, steam warships were seen as fire-belching behemoths that had a short logistics capability--typically steaming for three days would deplete the wood/coal supply. They were more often than not relegated to backwater theaters that had no real use for their capabilities. The diplomatic results of the new technology caused discomfort in world politics. Nations that never had to disagree with their neighbors found themselves arguing over territorial rights for the purpose of strategic resupply. This significantly affected the development as can be seen in the body of this thesis. As Bernard Brodie has said,

> . . . the modified geography of relative position and distance affected diplomatic as well as strategic [affairs]...suddenly, those nations that didn't have a strong industrial base found themselves losing to those that did...[20]

There was still an uncomfortable void in the operational level of war. This feeling is accurate, the author believes, because the strategists and great naval theorists of the time had an uncomfortable feeling. Mahan felt, even as late as 1891, that steam propulsion's history had yet to be written.

As one can only make weak attempts at arguing with a great naval theorist like Mahan, the author will not attempt it. Steam's relative importance to the overall strategic and operational design of those nations that use its power is a history still being written.

Suggestions for Further Research

This study briefly covers the expansive material on the subject of technology's influence in the strategic and operational design of the United States. Further study should be made into technology's role in the pre-Civil War American strategy and society.

Certainly, the Union Navy's role as the descendent of the United States Navy, its role in the Civil War and the technological edge enjoyed by the Union Navy over the Confederate Navy should be fully researched.

As we gain an understanding of new technology, research must assure America's continued lead in this vital element. It can be argued that the United States' affinity toward technology plays a role as another element of national power. This avenue should be more fully explored.

How steam propulsion affected joint operations during the Civil War and the diplomatic efforts after the war should be fully explored. Historical retrospective is the single most positive method of validating our current direction in this important area. New technology development is an ongoing concern; however, analysis must be done on our past successes and failures continuously so that maximum benefit can be reaped from the lessons of the past.

<u>Epilogue</u>

This thesis' has analyzed technology's effect on the operational and strategic levels of war. Through analysis of the United States Navy's introduction of the steam warship into the fleet can be seen the effects of new technologies on naval society and a nation's relations with its neighbors.

No one argues that steam propulsion significantly changed the way nation-states conducted themselves overseas. This is readily apparent to most scholars and avid hobbyists. What has been more difficult to discern is the relative importance of technology on the way men go to war.

The Persian Gulf War experience as the first post-Cold War conflict was unique in its insight into the use of modern computer technology as a combat multiplier.

This period in world geopolitical history is not unlike earlier times. There is retrenchment to a simpler defense posture. Less overseas presence means forces are not immediatly available in a potential hot-spot as was the case for the last fifty years.

Declining defense budgets demand that programs be cut, which brings the vehement cries of many industry and defense representatives who claim that the quickest way to ensure a return to combat is through a weakened defense.

The parallels that can be drawn between the first half of the 19th century and today are striking. Declining budget allocations for defense research, shrinking military forces, and a mood of retrenchment and isolationism are slowly creeping in to our society's fabric.

The lessons to be learned from the past demand careful scrutiny, and deserve legitimate consideration.

ENDNOTES

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